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and Brian L. Hamshere

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Weapons Systems Division
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ABSTRACT

In recent years it has been discovered that a form of the high explosive RDX exists which is identical to conventional RDX grades, with the exception that it is significantly less sensitive to shock stimuli in cast-cured polymer bonded explosives. This RDX, known as Reduced Sensitivity RDX, has the potential to provide major benefits in the field of Insensitive Munitions, particularly in sympathetic detonation scenarios. It has been shown that the Grade A RDX produced in Australia by ADI Ltd is a Reduced Sensitivity RDX.

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Executive Summary

Cyclotrimethylene trinitramine (RDX) is the most widely used crystalline high explosive in military applications. The vast majority of in-service high explosives across all applications contain RDX. Its advantages include respectable performance, reasonable insensitivity, ease of manufacture and acceptable low cost. Whilst many other explosive ingredients have been developed and occasionally adopted (typically for specialised applications), this excellent balance of performance, safety and economic factors has not been replicated or exceeded.

With most western defence forces now having a policy that requires the procurement of ordnance that complies with Insensitive Munitions (IM) protocols, there is considerable interest in developing high explosives that assist in meeting this goal. Consequently, much research has been directed to producing powerful but less sensitive explosives. Recently it has been discovered that certain existing manufacturing methods for RDX produce a grade of RDX that has additional benefits above the accepted norm. Specifically, the grades referred to as Reduced Sensitivity RDXs show reduced shock sensitivity in cast polymer bonded explosives (PBXs). This property is of considerable importance when designing a munition to pass a sympathetic detonation test such as the Stack Test. The implications for IM compliance are significant, especially as sympathetic detonation is perhaps the most difficult test to pass (particularly for larger ordnance items). The 'no additional cost' aspect of this development makes it more likely to be rapidly accepted and adopted.

This report examines the current status of research and development into Reduced Sensitivity RDX (RS-RDX) by way of literature review. The findings of the DSTO research programme are examined in detail and include formal reporting of major progress in this area.

Authors

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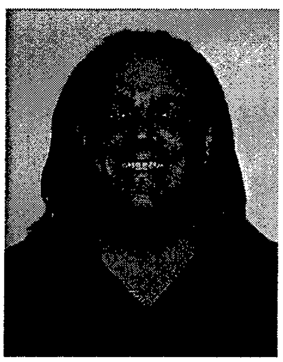
After completing his PhD in synthetic and physical organic chemistry at Flinders University, Ian spent two years at the University of Melbourne as a post-doctoral fellow where he studied resin derived carbon composites. Since joining the Explosives Group at DSTO in 1998 he has been working in three main research areas: formulation and testing of polymer bonded explosives, the synthesis and characterisation of the insensitive explosive FOX-7, and investigations into Reduced Sensitivity RDX, a grade of RDX with significant potential in the insensitive munitions area.



Mark D. Franson
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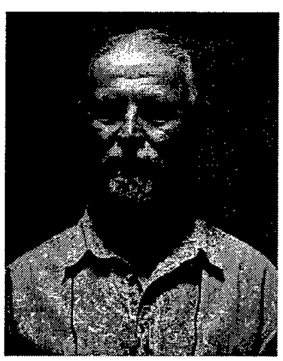
Mark joined Weapons Systems Division with a Bachelor of Applied Chemistry degree in 2002. He spent several years previously at the Ian Wark Research Institute (UniSA) conducting academic research into polymer science and surface modification. Currently Mark is working with the development of new polymer bonded explosives and NTO-containing explosive compositions, while studying toward his Masters degree in Defence Technologies.



Brian L. Hamshere
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Since 1977 Brian Hamshere has worked in the area of composite energetic materials. Earliest work concentrated on solid composite rocket propelants including high burn rate, low signature and low vulnerability formulations. Considerable effort was expended on developing a plateau burning propellant for the Nulka hovering rocket and assisting in the technology transfer to industry. More recently his attention has been directed towards formulating and developing polymer bonded explosives. Much of this work has centred on the explosive for the Penguin ASM warhead and on investigating explosive formulations for Insensitive Munitions.

Contents

Abbreviations

ADI	ADI Limited
AO	Anti-oxidant (2,2'-methylene-bis[6-tert-butyl-4-methyl phenol])
ARX	Australian research explosive
DHE	N, N'-di(2-hydroxyethyl) dimethyl hydantoin
DOA	Dioctyl adipate
DSTO	Defence Science and Technology Organisation
ESD	Electrostatic Spark Discharge
F of I	Figure of Insensitiveness
HMX	Cyclotetramethylenetetranitramine
HTPB	Hydroxyl terminated polybutadiene
IM	Insensitive Munitions
IPDI	Isophorone diisocyanate
I-RDX	Insensitive RDX (SNPE)
LSGT	Large Scale Gap Test
MRL	Materials Research Laboratory (DSTO)
NOL	Naval Ordnance Laboratory
PBX	Polymer bonded explosive
PBXN	PBX formulation qualified for in service use by the US Navy
PBXW	PBX experimental formulation developed by Naval Surface Warfare Center White Oak (USA)
RDX	Cyclotrimethylenetrinitramine
RO	Royal Ordnance PLC, Bridgwater UK
RS-RDX	Reduced Sensitivity RDX
SEM	Scanning electron microscopy
SEX	1-acetyl-3,5,7-trinitro-1,3,5,7-tetrazacyclooctane
SME	SNPE Matériaux Énergétiques
SNPE	Société Nationale des Poudres et Explosifs
TNO	Netherlands Organisation for Applied Scientific Research
TNT	2,4,6-Trinitrotoluene
T of I	Temperature of Ignition
TPB	Triphenyl bismuth

1. Introduction

Cyclotrimethylene trinitramine (RDX) is the most widely used crystalline high explosive in military applications. The vast majority of in-service high explosives across all applications contain RDX. Its advantages include respectable performance, reasonable insensitivity, ease of manufacture and acceptable low cost. Whilst many other explosive compounds have been developed and adopted (typically only for specialised applications), this excellent balance of performance, safety and economic factors has not been replicated or exceeded.

Recently it has been discovered that certain existing manufacturing methods for RDX produce a grade of RDX that has additional benefits above the accepted norm. Specifically, the grades referred to as Reduced Sensitivity[1] RDXs (RS-RDX) show reduced shock sensitivity in cast polymer bonded explosives (PBXs).

Any reduction in shock sensitivity is of considerable importance when designing a munition to pass a sympathetic detonation test such as the Stack Test. The implications for IM compliance are significant, especially as sympathetic detonation is one of the most difficult tests to pass (particularly for larger ordnance items).

2. Literature Review

2.1 SNPE Publications

The concept of RDXs with reduced shock sensitivity was first "discovered" by the Explosives and Propellants section of the French company SNPE[2]. SNPE announced [1] that the use of one of their existing grades of RDX resulted in a reduction in shock sensitivity of cast-cured polymer bonded explosives compared with the equivalent formulation manufactured using conventional RDX. They referred to this reduced sensitivity RDX as Insensitive RDX (I-RDX). The specific claims reported in the earliest paper [1] obtained by DSTO were:

- I-RDX and conventional RDX could not be differentiated through chemical, physical, safety characterisation and even shock sensitivity tests on the raw materials.

[1] RDX grades of reduced sensitivity were initially called insensitive RDXs in line with the SNPE convention. Recently the term Reduced Sensitivity RDX, or RS-RDX, has been proposed. The authors believe this term more appropriately describes the material and have adopted this terminology in all cases except when referring to the SNPE material which SNPE has specifically called Insensitive RDX (or I-RDX).

[2] SNPE Explosives and Propellants is now known as SME Explosives and Propellants but they remain part of the SNPE group of companies and still refer to their Insensitive RDX as SNPE I-RDX.

- I-RDX and conventional RDX can be produced with the same ranges of particle size distributions.
- I-RDX can be obtained from both Type I (Woolwich) and Type II (Bachman) RDX.
- The differences between I-RDX and conventional RDX are evident through shock sensitivity characteristics of cast PBXs. Examples were given for PBXN-109 and PBXW-115[3] type formulations.
- The effect on shock sensitivity of melt-cast explosives or pressed PBXs using RDX seems to be much less significant. No shock sensitivity data was published for such formulations.
- It was noted that the use of I-RDX does not modify any properties of the PBX (such as ageing, response to thermal stimuli etc) other than the shock sensitivity properties.
- Examples were provided indicating that the use of I-RDX has benefits in response to Sympathetic Detonation and Heavy Fragment Impact scenarios. This information is apparently the result of numerical simulation based on (unknown) small-scale test results.

A later paper [3] reported that the critical diameter of PBXN-109 containing I-RDX was twice that of the same formulation containing conventional RDX.

Comparative analysis [3, 4] of Insensitive and conventional RDX based on chemical purity, internal defect measurements, thermal stability and microscopic examination did not determine any relationship between these properties and the shock sensitiveness of the resultant PBXs.

Further information about the conversion of Bachman RDX into I-RDX was detailed in 2001 [4]. Batches of conventional RDX from two suppliers, one of which was identified as Holston Army Ammunition Plant, were converted into I-RDX by the SNPE process. It is of interest to note that the treatment process does not significantly alter the levels of the major impurities HMX and SEX (1-acetyl-3,5,7-trinitro-1,3,5,7-tetrazacyclooctane). The levels of both impurities are significantly higher in the converted batches compared with the "genuine" SNPE I-RDX.

Recent results from SNPE [5] showed that excellent batch-to-batch reproducibility of I-RDX is routinely obtained by testing the shock sensitivity of three formulations manufactured from a number of different batches of I-RDX. A brief ageing study on formulation B2213 (PBXN-109 type) confirmed that the use of SNPE I-RDX does not affect ageing properties of the PBX. No information was provided indicating whether or not the ageing effects of SNPE treated Bachman RDX has been assessed.

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[3] The shock sensitivity value reported for PBXW-115(Aust) in this and other papers by SNPE authors is incorrect. The correct value from the MRL Large Scale Gap Test (LSGT) is 86 cards, 6.3GPa [2]

This paper also contained introductory details on a study using microtomography and atomic force microscopy to quantitatively analyse defects in both the explosive formulation and at the explosive crystal surface. Early indications are that a relationship may exist between the crystal heterogeneity and the shock sensitiveness in PBXN-109.

SNPE confirmed [5] that the process they use for producing I-RDX is a recrystallisation technique and preliminary results were presented indicating that the process seems to also be effective for HMX.

2.2 DSTO Publications

Previous work carried out at DSTO provided examples that the Grade A[4] RDX produced in Australia by ADI Ltd has properties consistent with it being a RS-RDX. Both for PBXW-115 [2] and PBXN-109 [7] formulations, the PBXs manufactured with Grade A RDX had significantly lower shock sensitivities and increased critical diameters. No differences in the small-scale sensitiveness testing results of either the RDXs or the PBXN-109 were detected (comparative testing was not performed on PBXW-115 formulations).

Additional tests [7] to examine a batch of 'improved' RDX supplied by Dyno Nobel showed that whilst the material imparted improved processing properties on the PBX formulation, due to the improved morphology of the recrystallised RDX compared with conventional RDX, it was not a RS-RDX. Dyno Nobel [8] also confirmed this finding. The same DSTO study [7] reported that the replacement of some of the Grade A RDX in the Australian PBXN-109 formulation with HMX did not significantly modify the reduced shock sensitivity of the PBX.

Studies [9, 10] into RDX/polyethylene wax compositions contain data that provides a possible insight into the effect of RS-RDX on the shock sensitivity of pressed PBXs. The shock sensitivity of the pressed compositions increases as the density increases, however for Grade A RDX there is a distinct change in the slope of the curve at higher densities which is not apparent for Grade B[5] RDX (which has been shown to not be a RS-RDX (section 3.2.1)). This could indicate that at the pressing loads required to obtain the higher densities the RDX crystals are damaged, negating the shock sensitivity benefits of using a RS- RDX. At lower densities the RS-RDX is thought to be undamaged and the full benefit is realised through reduced shock sensitivity. Comparison with equivalent formulations using Grade B RDX shows that at lower densities the formulation containing Grade A RDX is less sensitive than the Grade B formulation. At higher densities the shock sensitivities are essentially identical.

[4] Grade A RDX is type I, recrystallised [6].
[5] Grade B RDX is type I, boiled and milled [6].

2.3 Other Publications

SNPE Insensitive RDX has reportedly [11] been evaluated in a US Army led Foreign Comparative Test Program which included various IM tests in 155mm artillery projectiles filled with PBXW-108MOD (RDX + HTPB binder) and MNX194 (RDX + wax). No results have been released to DSTO from this program.

A collaboration between NEXPLO Bofors AB and Finnish researchers reported [12] that a recrystallised RDX produced by NEXPLO Bofors AB was used to make a PBXW-115 type formulation (RDX/Al/AP/binder) that could be classified as an Extremely Insensitive Detonating Substance (EIDS). The recrystallised RDX was claimed to be a RS-RDX however insufficient evidence is provided to definitively confirm this claim. Reductions in shock sensitivity compared with the formulation containing conventional RDX were reported.

Dyno Nobel ASA released a product brochure [8] that announced their capability to produce commercial quantities of RS-RDX by treating their Type II RDX. Shock sensitiveness data for PBXN-109 formulations was detailed to support this claim. A reduction in shock sensitivity for a pressed PBX formulation was also described however it is impossible to assess the significance of this with the available data. The Dyno RS-RDX is reported to have HMX levels of 0.1 - 0.3%.

Whilst not specifically involving RS-RDX, the research carried out at TNO Prins Maurits Laboratory [13] into RDX crystal quality and its influence on properties of formulations is still relevant. For cast PBXs it was found that the presence of crystal defects had a more significant influence on the shock sensitivity of the PBX formulation that the particle size of the RDX. No correlation between RDX crystal defects and shock sensitivity was found for extruded PBXs, this was attributed to the additional voids present in the polymeric binder or at the binder - RDX interface.

3. Current Work

The work described herein is from studies in the Explosives Group at DSTO Edinburgh. The primary purposes of the research were 1) a comparative study of Australian RDX, SNPE I-RDX and conventional Type II RDX grades, focussed on formulation shock sensitivity and 2) to investigate the scope of benefits of RS-RDX grades by exploring effects in various formulations.

3.1 RDX Comparison

3.1.1 RDX Samples

Six different batches (table 1) of RDX were used in this project. Two batches of ADI Grade A RDX from different facilities were examined, primarily to enable comparison between previous research and current projects. Type II RDX from Dyno Nobel was selected as being representative of a conventional 'non-insensitive' RDX grade. The class 5 (fine) RDX from Royal Ordnance was used in the cast-cured PBX formulations to enhance processability. ADI Grade B RDX was used to provide results from a different grade of Type I RDX that was expected not to be a RS-RDX.

Table 1. Source and type of RDX

Manufacturer	Description	Lot no.
Dyno Nobel	Type II, Class 1	DDP01J001-042
SNPE	I-RDX	0719S00
ADI (Albion)	Type I, Grade A, Class 1	R634
ADI (Mulwala)	Type I, Grade A, Class 1	11852A
ADI (Albion)	Type I, Grade B	B/B3963
RO, Bridgwater	Type I, Class 5	1659

3.1.2 SEM Imaging

Examination by scanning electron microscopy (SEM) of the six RDX variants listed in Table 1 shows some distinct differences (figs. 1-6). Numerous fine particles are present amongst the larger grains of the two European products. Generally, the SNPE and ADI Grade A RDX particles are more rounded than that of Dyno Nobel indicating that the ADI and SNPE materials have been recrystallised whereas the Dyno Nobel has not. The ADI Grade B RDX has very irregular morphology and a wide range of particle sizes, consistent with a milled sample.

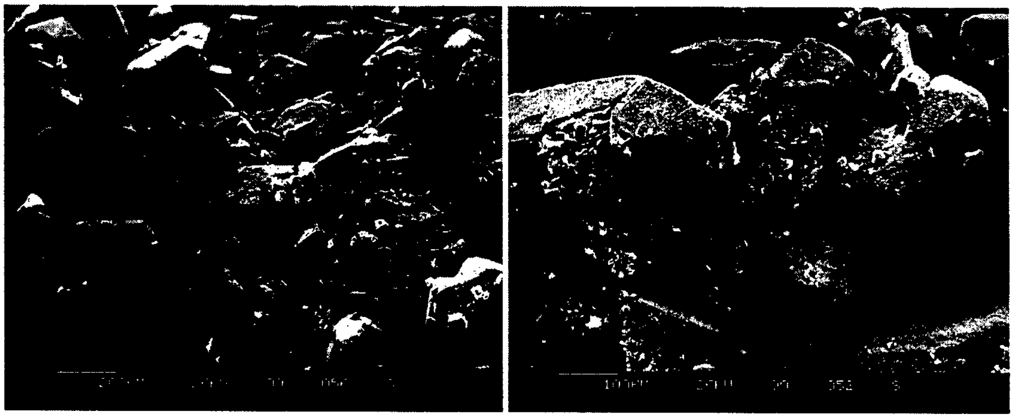

Figure 1. SEM images of Dyno Nobel RDX

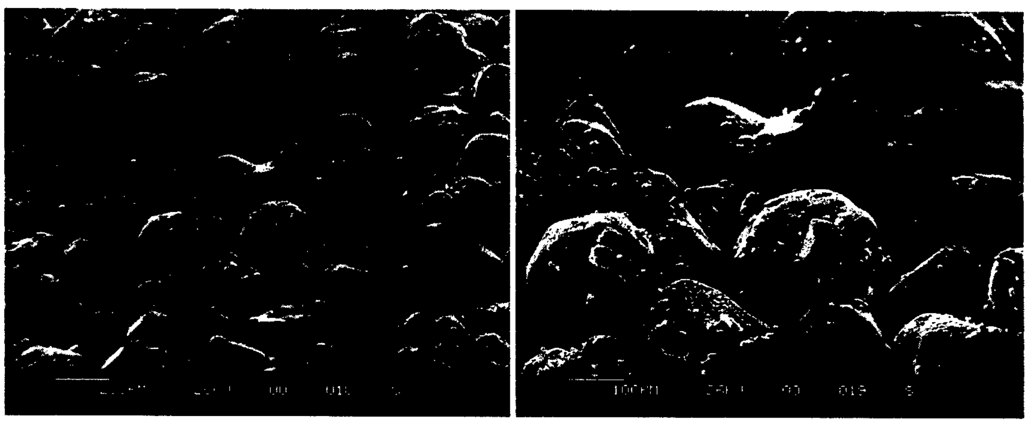

Figure 2. SEM images of SNPE I-RDX

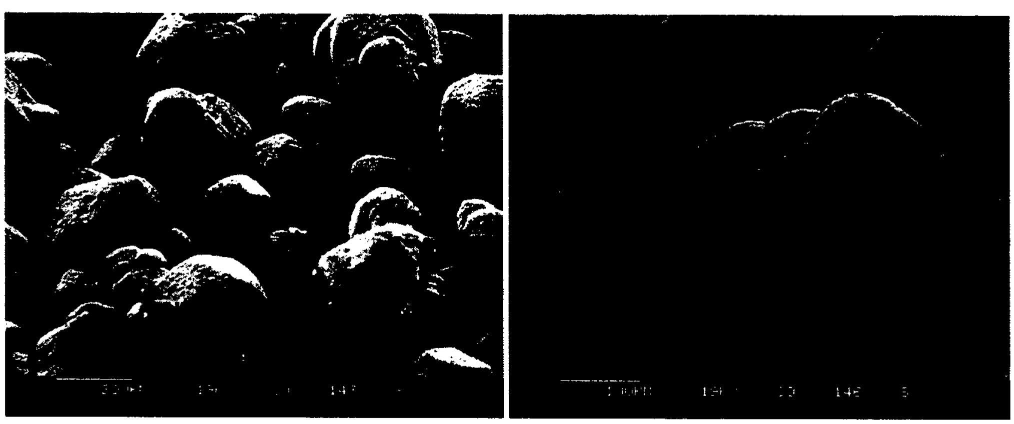

Figure 3. SEM images of ADI Grade A RDX (Albion)

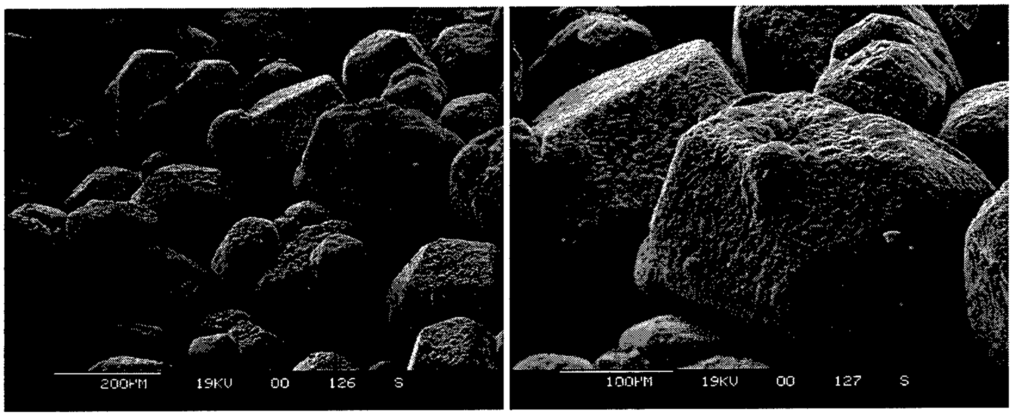

Figure 4. SEM images of ADI Grade A RDX (Mulwala)

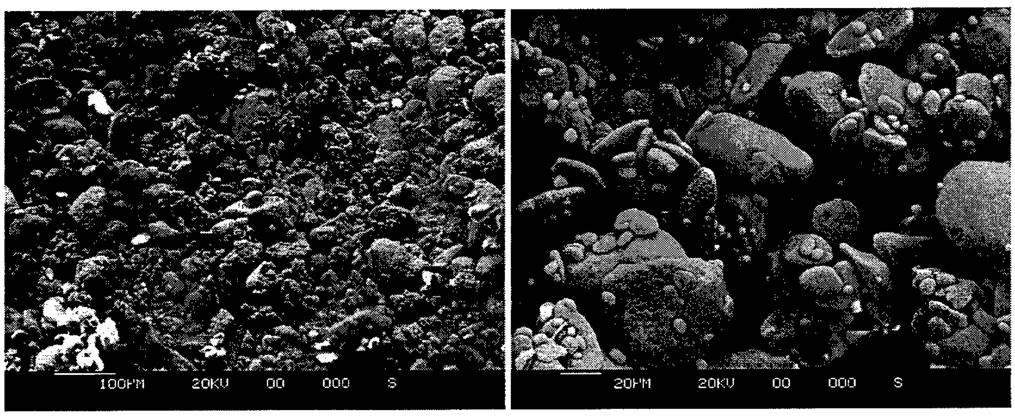

Figure 5. SEM images of ADI Grade B RDX

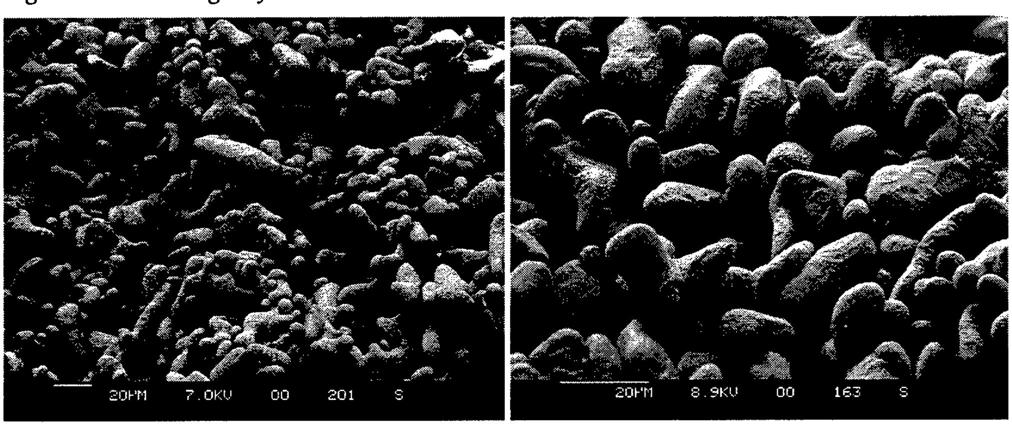

Figure 6. SEM images of Type I, Class 5 RDX

3.1.3 Particle Size Analysis

Particle size analysis was performed on a Malvern Mastersizer 2000 with HydroS dispersion unit. The samples were dispersed in chloroform. The results (table 2) show some variation across the RDX samples of primary interest (Dyno Type II, I-RDX and Grade A) however any effect that these variations might have on the shock sensitivity of the formulations is not expected to be significant.

Table 2. Particle size analysis of RDX samples

RDX	Particle Size Analysis	
	d(0.5) µm	Span
Dyno Type II	306	1.3
SNPE I-RDX	213	1.7
ADI Grade A (Albion)	268	1.4
ADI Grade A (Mulwala)	224	1.1
ADI Grade B	55	2.5
RO Class 5	25	1.8

3.1.4 Sensitiveness Testing

Small-scale sensitiveness testing was performed on all RDX batches. The differences between the RDX samples of primary interest (ADI Grade A, SNPE and Dyno) were not considered statistically significant.

Table 3. Sensitiveness test results for RDX samples

	Dyno Type II Class 1	SNPE I-RDX	ADI Grade A (Albion)	ADI Grade A (Mulwala)	ADI Grade B	RO Type I Class 5
Rotter Impact (F of I[1])	70 (10.1)	70 (10.5)	90 (12.1)	90 (11)	80 (8.5)	60 (6)
BAM Friction (N)	120	120	120	144	120	96
T of I[2] (°C)	212	220	228	220	229	228
ESD[3] Ignition (J)	4.5	0.45	4.5	4.5	0.45	4.5
ESD No ignition (J)	0.45	0.045	0.45	0.45	0.045	0.45

[1] Figure of Insensitiveness, evolved gas volumes (mL) in parentheses
[2] Temperature of Ignition
[3] Electrostatic spark discharge

3.2 Shock Sensitivity

The routine method employed by DSTO for determining the shock sensitivity of explosive formulations is by the MRL Large Scale Gap Test [14]. This technique, as with equivalent techniques used by other organisations, is based on the NOL LSGT. In common with other gap tests, the gap material is placed between the donor and the acceptor and the thickness of gap material required to result in a 50% chance of detonating the test explosive with the output from the donor charge is determined. The 50% gap thickness is the measured quantity that provides an indication of the shock sensitivity of the explosive under test.

3.2.1 ARX-2020

The generic PBX formulation ARX-2020 (78% RDX, 22% binder) was selected as the vehicle in which to assess the relative shock sensitivities of the various grades of RDX. Because of the less than optimum RDX particle size distribution a relatively high binder level was employed to ensure good quality castings. The ingredients and mix/cast/cure procedure are outlined below (tables 4 & 5). Each variant was produced in a 6 kg batch, cast under vacuum with vibration into LSGT tubes, and cured at 60°C for 7 days.

Table 4. Ingredients of ARX-2020 formulation

Material	Weight (g)	Weight (%)
Hydroxyl terminated polybutadiene R-45HT (HTPB)	600	10
Dioctyl adipate (DOA)	614	10.24
2,2'-methylene-bis[6-tert-butyl-4-methyl phenol] (AO)	8.4	0.14
N, N'-di(2-hydroxyethyl) dimethyl hydantoin (DHE)	21.6	0.36
Triphenyl bismuth (TPB)	1.2	0.02
RDX (coarse)	4212	70.2
RDX (fine)	468	7.8
Isophorone diisocyanate (IPDI)	75.6	1.26
Total	6000	100

The RDX used in each formulation is a bimodal blend of 10% fine material (Type I, Class 5, Lot 1659) from Royal Ordnance, Bridgwater, UK, and 90% of the RDX (coarse) to be evaluated. The fine RDX being Type I is therefore free from HMX. The fine RDX was added to improve the processing quality of the PBX and to ensure void free LSGT test samples.

Table 5. Mix procedure for ARX-2020 formulation

Step	Ingredient/action	Mix time w/o vacuum (min)	Mix time with vacuum (min)
1	HTPB+DOA+DHE+AO+TPB	2	28
2	50% RDX blend	2	13
3	25% RDX blend	2	13
4	25% RDX blend	2	13
5	Scrape down		
6	IPDI	1	4
7	Scrape down		
8	Mix	0	60

Due to the nature of these formulations the main mix cycle (60 minutes with vacuum) was conducted after the addition of the curative (IPDI) to optimise mix quality.

This ARX-2020 study has been conducted with the RDX as the only variable - the PBX mixing and curing have all been conducted under the same conditions using ingredients from the same batch. This allows a direct comparison to be made of RDX shock sensitivity characteristics.

The shock sensitivity measurements were determined using the MRL LSGT [14], and are presented in Table 6.

Table 6. LSGT results for ARX-2020 formulations

RDX source	50% gap	
	Number of cards	Pressure (GPa)
Dyno Nobel	168	3.01
SNPE I-RDX	123	4.46
ADI-Albion	119	4.62
ADI-Mulwala	117	4.68
ADI (Grade B)	171	2.92

It is clear that both the SNPE I-RDX and the ADI RDX afford a considerable reduction in shock sensitivity. There is virtually no difference in shock sensitivity between the PBXs made with SNPE's I-RDX and ADI's Type I, Grade A, Class 1 RDX. The small differences in results between SNPE and ADI RDX are probably due either to minor batch variations or to differences in particle size distribution and particle morphology.

3.2.2 PBXW-115(Aust)

To provide additional comparative data between ADI Grade A RDX and SNPE I-RDX the latter was formulated into PBXW-115(Aust) and the shock sensitivity measured. The results (table 7) show that the Grade A and I-RDX gave essentially identical results which were significantly better than conventional Type II RDX.

Table 7. Shock sensitivity data for PBXW-115 formulations

RDX	50% Gap		Data Source
	Number of cards	Pressure (GPa)	
ADI Grade A	87	6.3	[2]
SNPE I-RDX	84	6.3	This programme
US Type II	130	4.7	[2]

3.2.3 RDX/TNT Melt-Cast Formulation

SNPE reported (section 2.1) that I-RDX did not significantly alter the shock sensitivity of melt-cast formulations. Given the absence of any data to support this finding and the significance of TNT based melt-cast formulations to the Australian Defence Force it was decided to evaluate the shock sensitivity of RDX/TNT (60/40) for each of the three RDX grades. The formulations, with no waxes added, were poured at 95°C into warm LSGT tubes, achieving a density of 1.71 ± 0.02g.cm^{-3} for the charges at ambient temperature. The results (table 8) clearly show that the use of RS-RDX grades does not influence the shock sensitivity of TNT based melt-cast formulations. This implies that the shock sensitivity of these formulations is dominated by something other than the nature of the RDX, as the variables in this study (conventional or RS-RDX, Type I or Type II RDX and different particle morphologies) made no difference to the shock sensitivity. One possible explanation is that the controlling factor in the shock sensitivity of the RDX/TNT formulations could be defects at the RDX - TNT interface, however there is no conclusive evidence to support this theory.

Table 8. Shock sensitivity of RDX/TNT (60/40) melt-cast formulations

RDX	50% Point	
	Number of Cards	Pressure (GPa)
ADI Grade A (Lot 11852A)	234	1.7
SNPE I-RDX	234	1.7
Dyno Type II	235	1.7

4. Discussion and Conclusions

It has been clearly demonstrated through this study that certain grades of RDX, referred to as Reduced Sensitivity RDX, have properties which when formulated in cast-cured polymer bonded explosives reduce the shock sensitivity of the PBX compared with equivalent formulations containing conventional RDX grades. It has also been shown that RS-RDXs do not affect the shock sensitivity of RDX/TNT melt-cast formulations. Prior results (section 2) indicated that the critical diameters of PBXs containing RS-RDX grades are increased.

The Type 1, Grade A, Class 1 RDX manufactured by ADI is equivalent to the I-RDX manufactured by SNPE in terms of its shock initiation pressure in polymer bonded explosives, and both are superior to conventional RDX grades including Type II and Grade B RDX. Sufficient evidence has been presented to conclusively state that ADI's Grade A RDX may be classified as a Reduced Sensitivity RDX.

Further investigation into pressed PBXs and other matrix types with RS-RDX would be of considerable value to expand the understanding of the scope and limitations of the shock sensitivity reducing benefits of RS-RDX grades. An understanding of the matrices in which RS-RDX is effective (or not) should also cast further light on the properties that make an RDX grade 'Reduced Sensitivity'. Studies of this nature are currently being initiated in the Explosives Group at DSTO.

It remains to be demonstrated whether or not the reduced shock sensitivity of cast-cured PBXs containing RS-RDX translates to actual IM benefits in ordnance systems. As previously discussed, the major benefit is anticipated to be in sympathetic detonation scenarios. A comparative study by the authors, examining sympathetic detonation of generic test pieces filled with PBXN-109 containing both RS-RDX and conventional RDX, has recently been completed. Results of this study, to be released imminently, showed that a reduction in standoff distance could be achieved for the generic test pieces by using RS-RDX in the fill. Further studies are still required on a range of ordnance items to examine the effect of scale and to demonstrate the scope of any benefits.

An important issue that remains outstanding at this point is the requirement for an analytical technique for RS-RDX. Whilst an RDX can be identified as being a RS-RDX by measuring the shock sensitivity of a PBX formulation, no measurement technique on the RDX has been identified as a way of classifying an RDX as RS-RDX or not. Until this technique is developed it will be difficult to establish standards for the production and use of RS-RDX grades. In spite of this, the authors believe that RS-RDX grades currently in production (which comply with existing standards) should be considered for use in all cast-cured PBX applications.

It is worth noting that the two batches of ADI Grade A used in this study were produced in 1986 (R634) and 2001 (11852A), demonstrating that the insensitive nature of Grade A RDX is not affected by ageing of the raw material. A study has recently commenced to confirm that there are no ageing effects on shock sensitivity of cast-cured PBXs containing ADI RS-RDX.

5. Acknowledgements

The ARX-2020 research was supported by funding from ADI Limited through the ADI-DSTO Collaborative Work Programme. The assistance of Tim Miller from ADI Ltd is gratefully acknowledged. The authors would also like to recognise the support that John Symes, Max Joyner and Bob Arbon provided in charge preparation and the staff at Proof and Experimental Establishment Pt Wakefield for assistance during the field trials.

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Literature Review and DSTO Evaluation

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19. ABSTRACT

In recent years it has been discovered that a form of the high explosive RDX exists which is identical to conventional RDX grades, with the exception that it is significantly less sensitive to shock stimuli in cast-cured polymer bonded explosives. This RDX, known as Reduced Sensitivity RDX, has the potential to provide major benefits in the field of Insensitive Munitions, particularly in sympathetic detonation scenarios. It has been shown that the Grade A RDX produced in Australia by ADI Ltd is a Reduced Sensitivity RDX.